# On the bias and shot-noise of the HI P(k)

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# O' HI, Where Art Thou?

- The distribution of the HI in the post-reionization era is almost unknown.
  This is relevant for S/N estimates now, and for cosmological analyses of real data. Mocks ?

- Conventional wisdom is that HI lives in low mass halos, 10^10 Msun/h above z=1.
  Bias is close to unity and shot noise is negligible.
  *Conventional wisdom is the body of ideas or explanations generally accepted as true by the public and/or by experts in a field[..]. It is not necessarily true and it is additionally often seen as an obstacle to the acceptance of newly acquired information. Reference: Wikipedia.*

- N-body simulations give contradictory results, and they are not able to account for all the obs.
  Complicated by radiative transfer.

- If we want to plan a HI-IM experiment above z>2.5, we should have an idea of how much signal is buried under the foregrounds.

# What do we know about the HI?

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We have data from Quasars' spectra, CDDF and cosmological abundance at various z.

$$\Omega_{\rm HI}(z=2.3) = 0.83 \times 10^{-3}$$

And a measurement of DLA bias at z=2.3 from Font-Ribera12

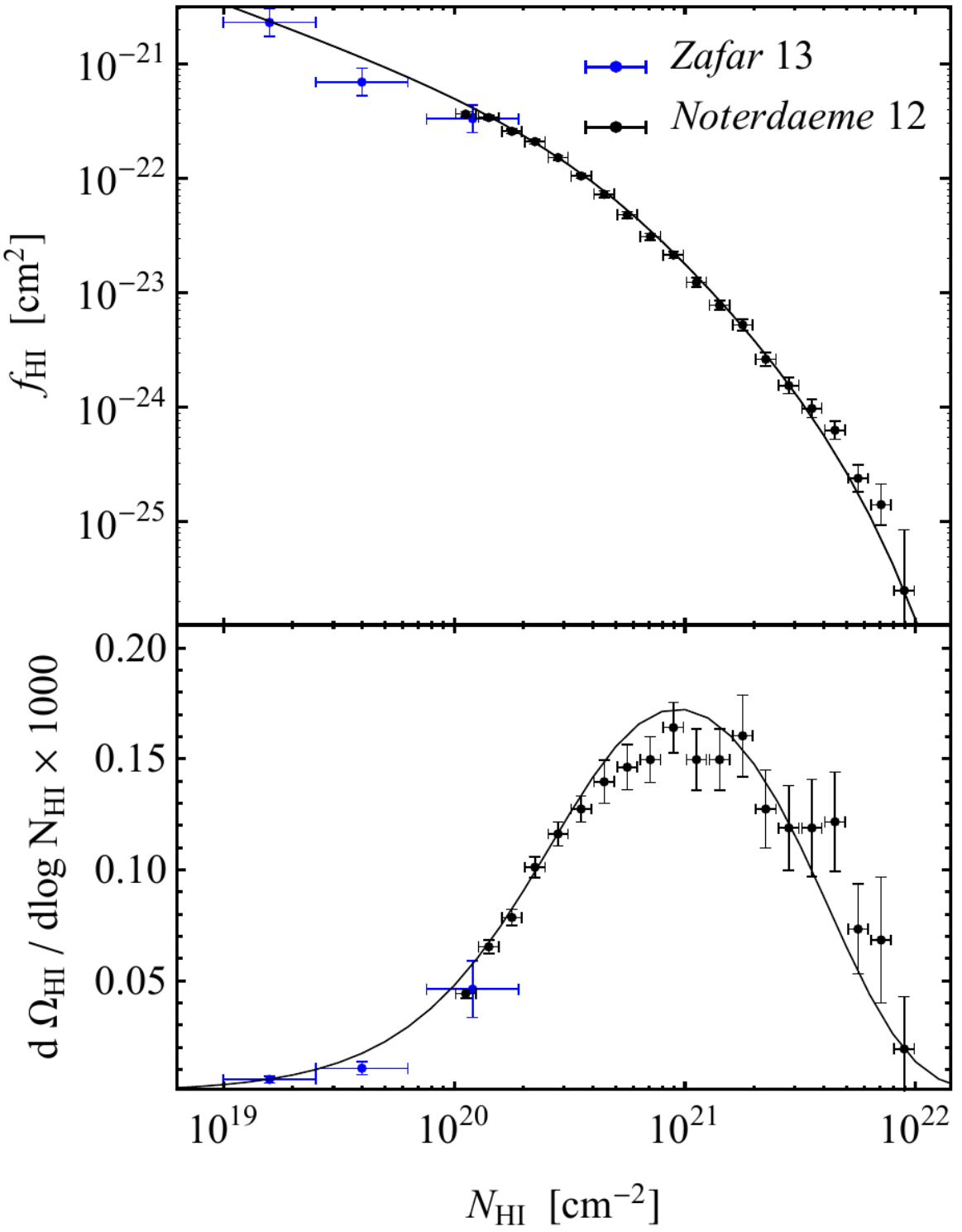
$$b_{DLA} = (2.17 \pm 0.2)\beta_F^{0.22}$$

The high value of DLA bias is hard to reproduce in Hydro's.

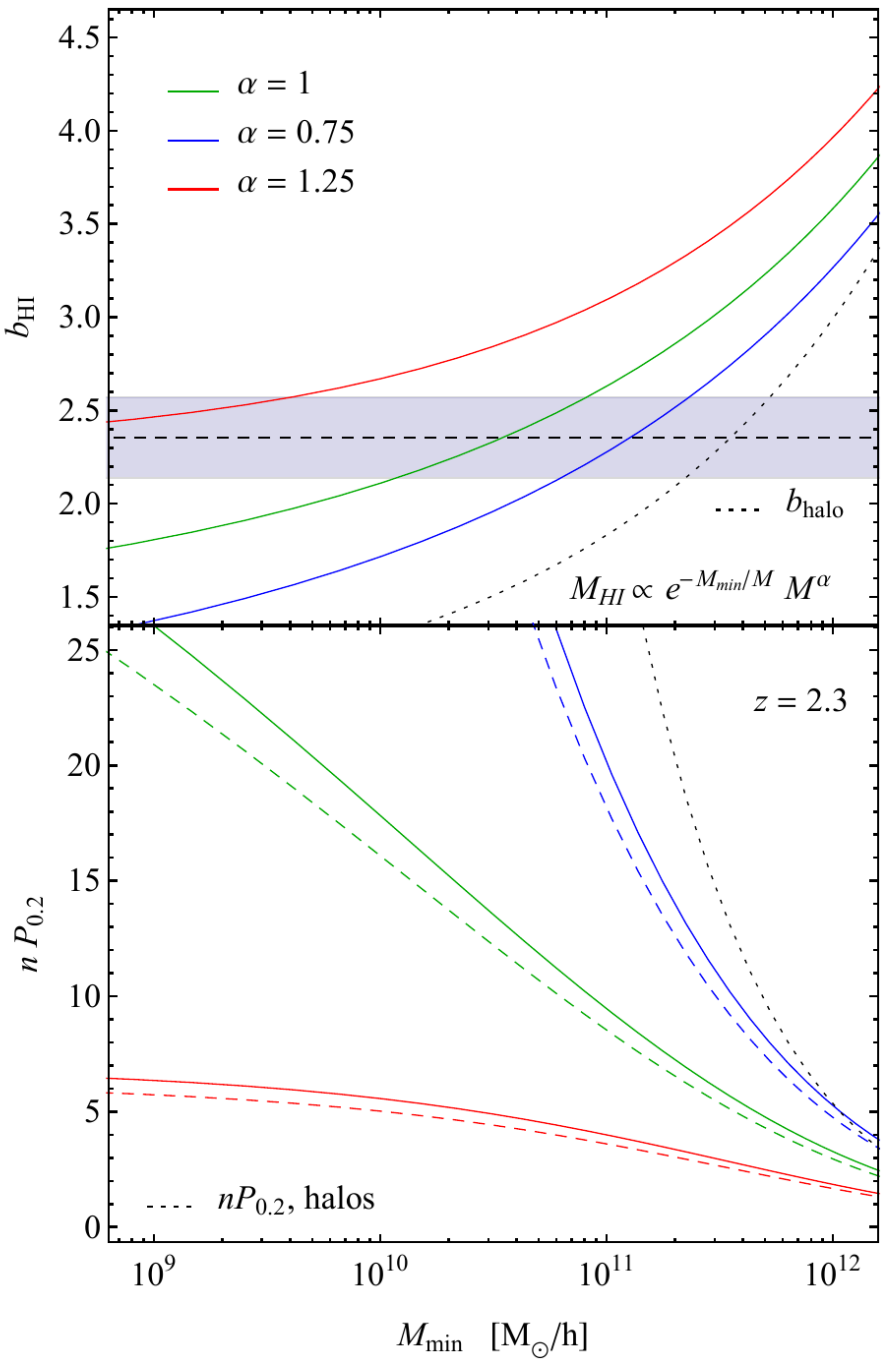
$$b_{DLA} \neq b_{HI}$$

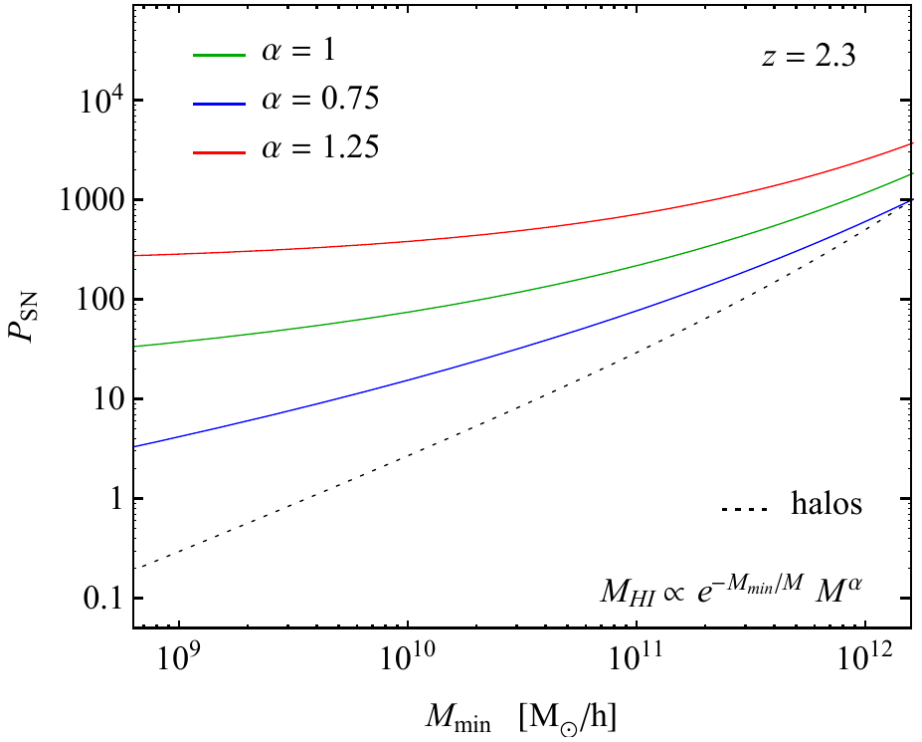
number weighted

mass weighted



# The model



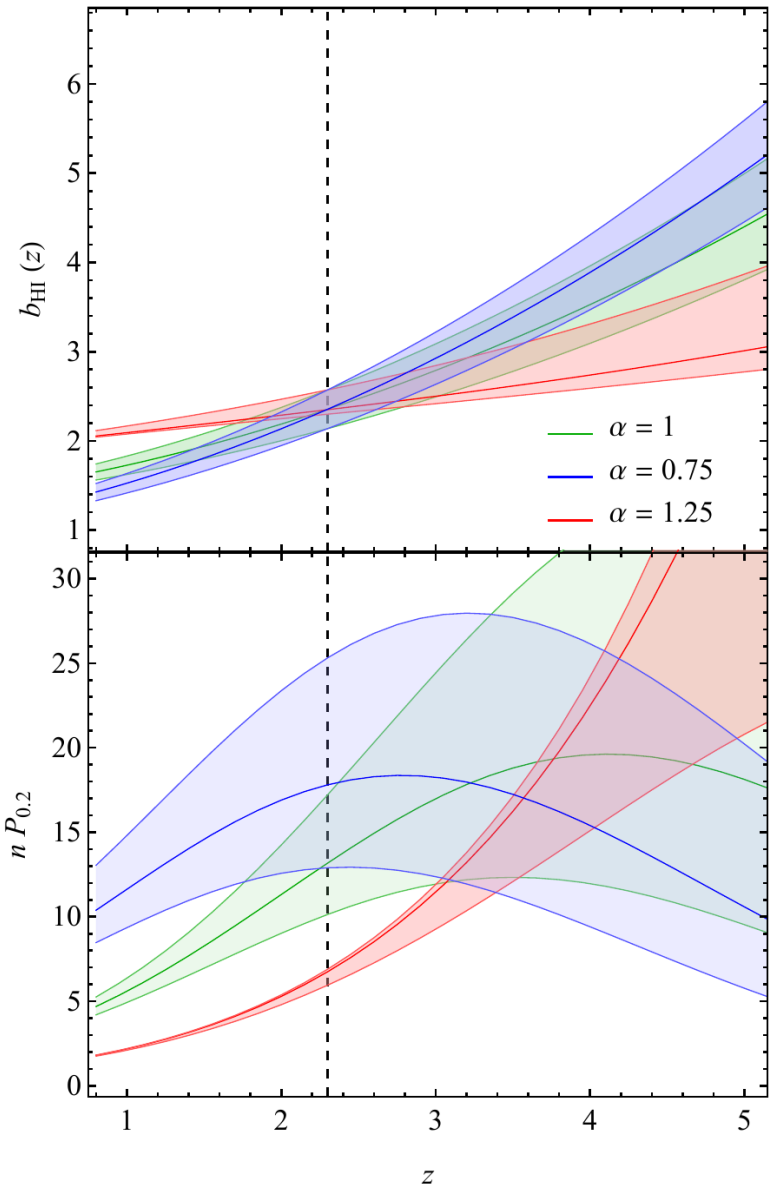




$$M_{\rm HI}(M,z) = \mathcal{C}(z)\,(1-Y_p)\,\frac{\Omega_b}{\Omega_m}\,e^{-M_{\rm min}(z)/M}\,M^{\alpha(z)}$$

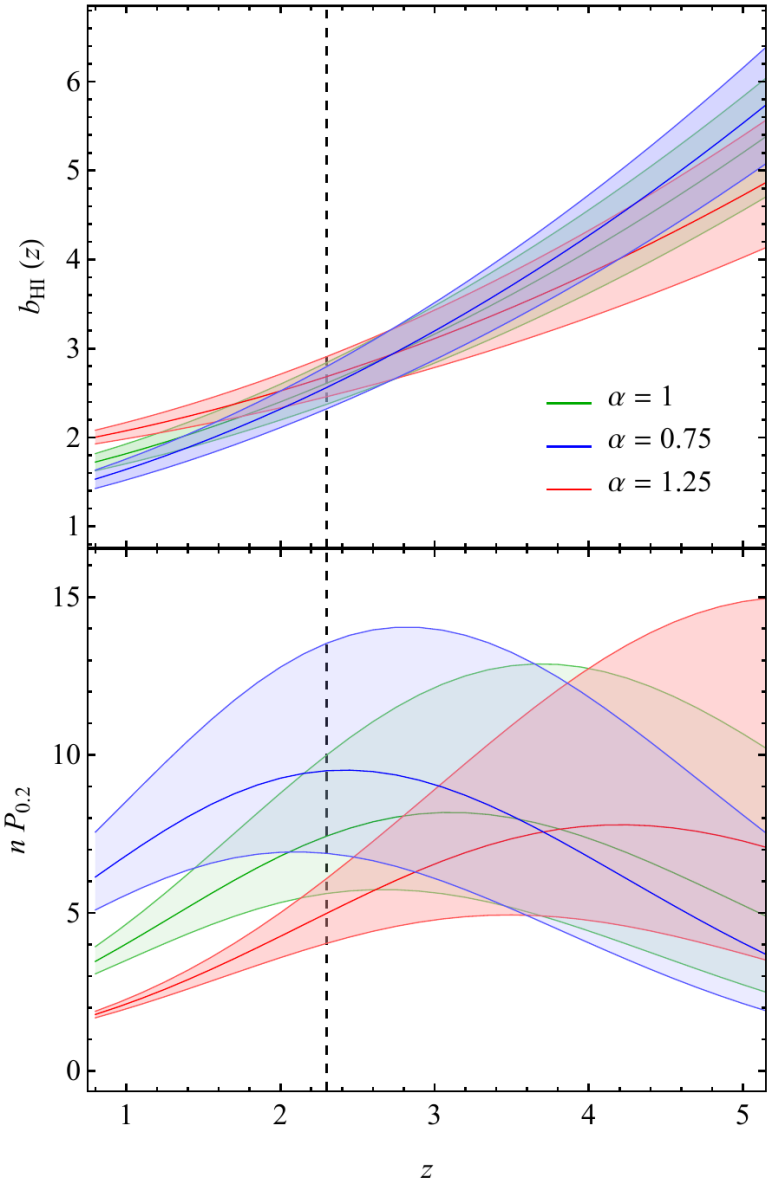
Weighing by mass yields larger bias and larger signal to noise than weighing by number.

nP is reasonably high at z=2.3 for low Mmin.

# Fitting to data




When DLA cross section does not depend on mass




When DLA cross section depends on mass

# Summary and Outlook

- HI resides in halos above Msun/h = few x 10^11 at z=2.3.
  HI bias could go up to 3, and shot-noise is also higher than expected,
  comparable to CHIME instrumental noise at k=0.2 Mpc/h.

- At low redshift, z<2, shot-noise wins over bias and it decreases S/N.
  Seo&Hirata15 assume b=1 and PSN=100 at z=1, including noise and wedge
  they get nP<1.  We have b=1.5 and PSN =500, ie a further decrease in S/N.
  Important for BAO constraints and reconstruction.
  (Assumptions on the UV background)

- At high z, relevant for cosmic visions, the SN is high, but it decreases above
  z >5. More QSO's spectra or direct measurements of HI will help constraining
  the remaining freedom of the model.

- New forecasts?